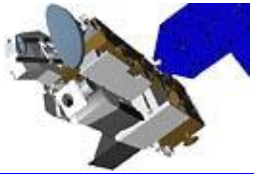

EARTH OBSERVING SYSTEM
MICROWAVE LIMB SOUNDER

MLS Instrument Operations Status Update

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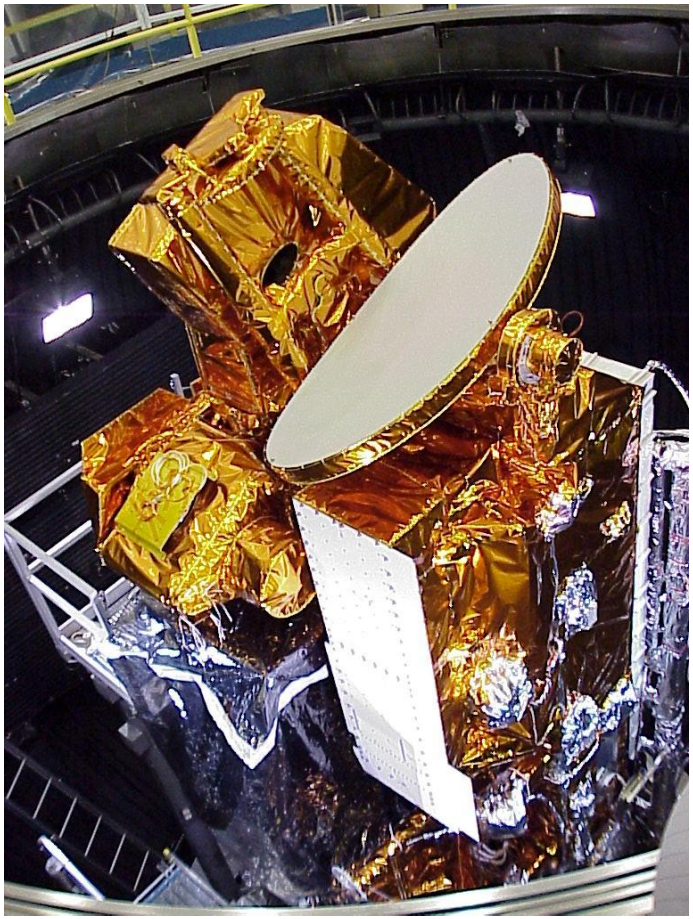
California Institute of Technology

Boulder, CO
September 28, 2010

Overview



- Overall Status
- MLS Significant Events
- Instrument Performance
- Anomalies In The Past Year
- Trend Updates
- Longevity Concerns
- Operational Plans
- Instrument Activity Requests
- Future Work

Overall Instrument Status

Overall, the MLS instrument has performed exceptionally well

- **The instrument has completed ~ 8,000,000 atmospheric scans and continues to do so every 24.7 seconds**
- **THz module exceeded its life requirement by over 3x and is now in standby mode with a plan for long term OH analysis measurements in August 2011 and June 2013**
  - **No OH product since December 2009**
- **All other MLS science products are still being produced 24/7**
  - **Some degradation in the HCl sensitivity and accuracy beginning February 2006 when HCl product generation was shifted from Band 13 to Band 14 data**

MLS Instrument Significant Events

Oct 2009 - Sep 2010

- **Aura MLS +6 Degree Pitch Measurement - Sep. 24, 2009**
- **MLS SIF3 Subsystem SEU Shutdown - Oct. 26, 2009**
- **MLS THz Laser Powered Down to Conserve Life - Dec. 13, 2009**
- **MLS Band 13 HCl Measurement - Jan. 05, 2010**
- **MLS FB08 Subsystem SEU Shutdown - Jan. 09, 2010**
- **MLS Moon Track 5 Measurement - Mar. 02, 2010**
- **MLS THz Scan Mechanism off - Mar. 02, 2010**

Instrument Performance

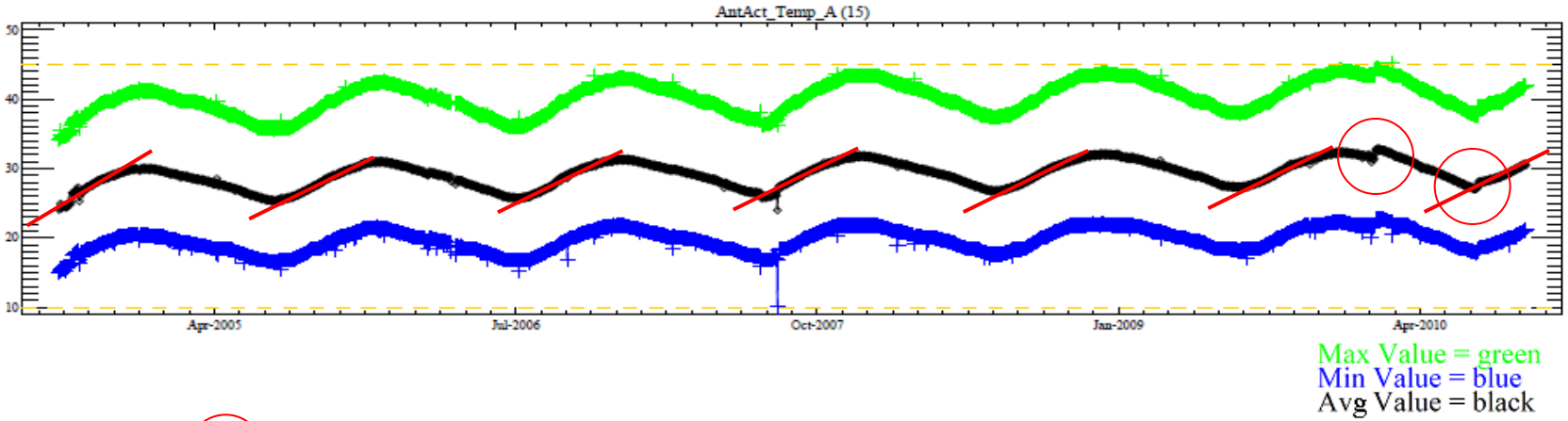
- **On-orbit gain and sensitivity trends remain consistent with the past six years**
  - **Reductions in signal gains have been noted in the 25 and 11 channel spectrometers**
  - **Gain adjustments implemented to maintain optimal science data**
    - **Current gain settings are good for ~ 1 additional year**
  - **Adequate gain adjustment remaining for several years of extended mission based on current trends**
  - **One potential tradeoff decision may be necessary in ~ 1 year**
    - **Details on Longevity slide**
- **AAA, GME and TSE mechanisms trends show no obvious sign of life limiting behavior based on routine monitoring of jitter performance**
- **NO MLS mechanism shut down anomalies since root cause identification and workarounds were implemented in 2007!**

Anomalies in the past year

- **MLS SIF3 subsystem SEU shutdown - Oct. 26, 2009**
  - **Affected products: O3, CO**
  - **Returned to service in 1 day**
- **MLS FB08 subsystem SEU shutdown - Jan. 09, 2010**
  - **Affected products: HO2, BrO**
  - **Returned to service in 2 days (Murphy visited on a Saturday)**

- **MLS AAA Temperature Anomaly**
  - **2 occurrences of a 1° temperature increase in Jan. and Jul. 2010**
  - **Suspected cause is slightly larger than usual wear product in the mechanism travel**
  - **In both cases the temperature returned to nominal seasonal values within a few months**
  - **No science data impact from this "anomaly"**
  - **Per the CogE, the AAA felt washer "is probably just losing fibers, in the same way that working at JPL causes us to lose hair everyday. We have lots of evidence of fiber shedding from these felt washers"**

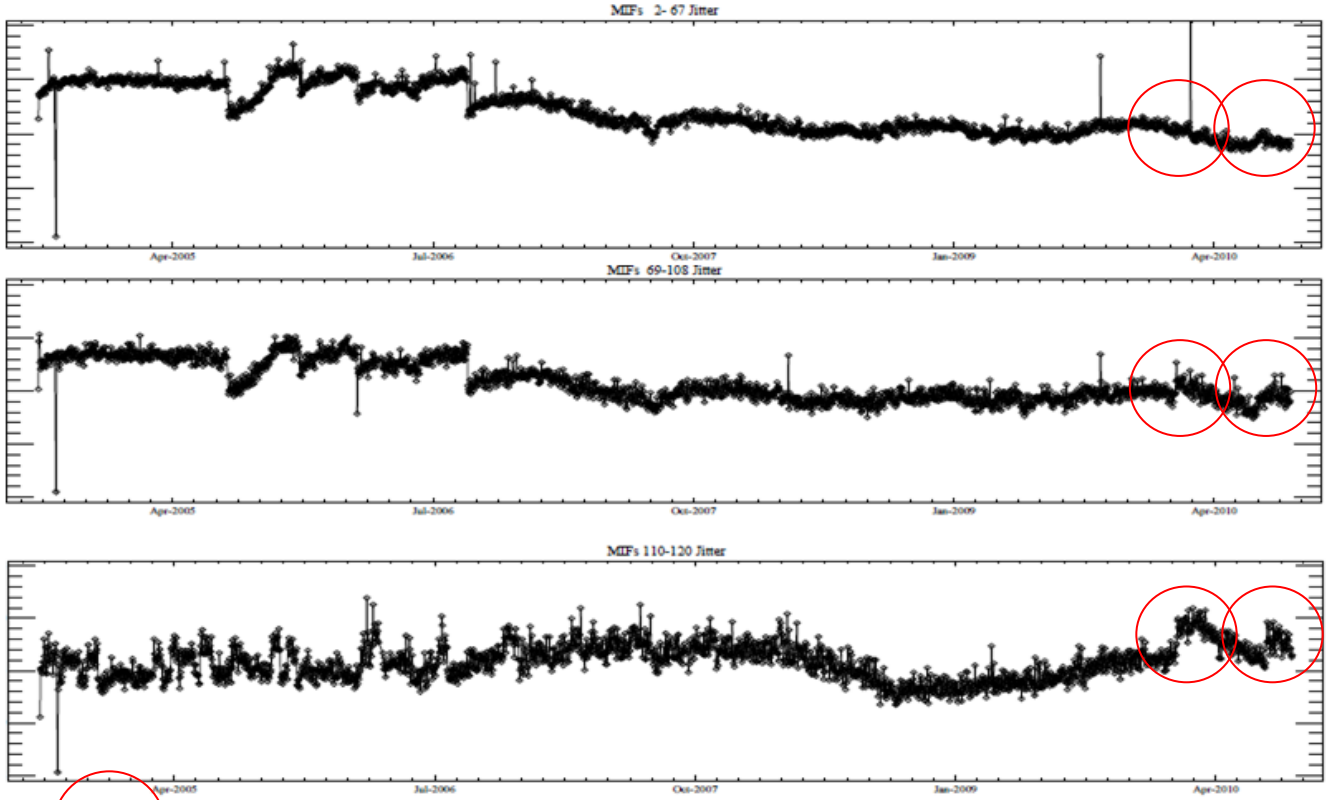
Trend Updates
AAA Temperature Trend
Activation to present



- **January and July 2010 temperature anomalies**
- **Temperature trend has returned to nominal seasonal values within a few months on both occasions**

Trend Updates
AAA Mechanism Jitter

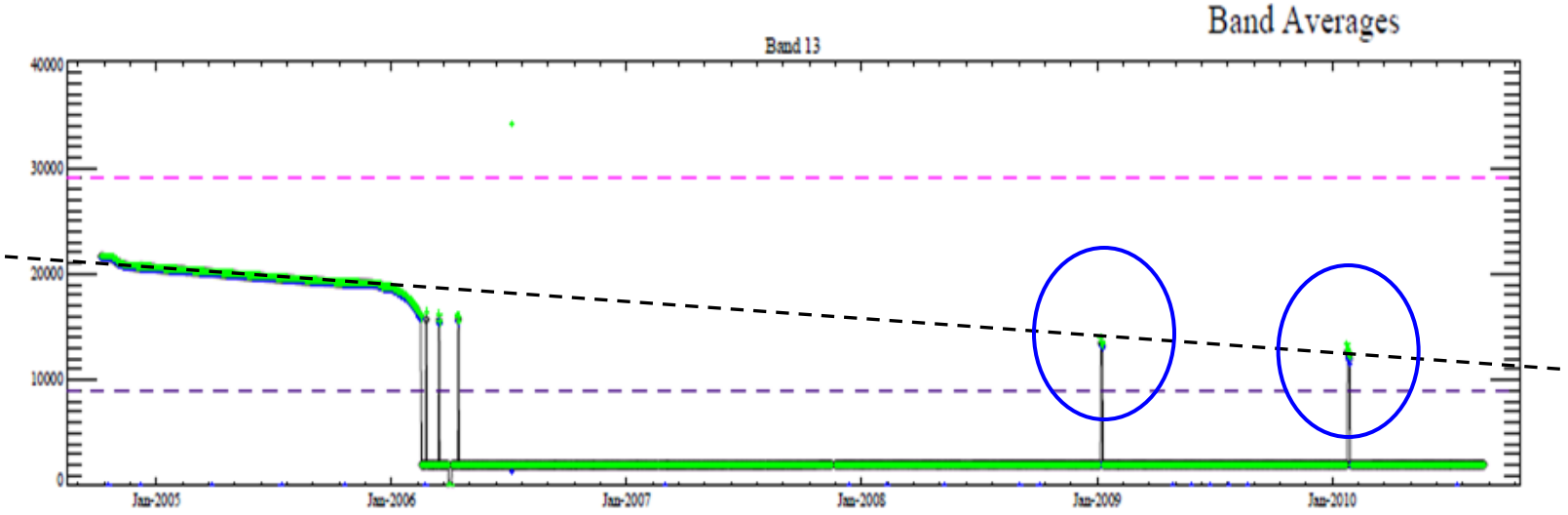
One panel for each velocity of MLS limb scan



- **January and July 2010 temperature anomalies**
- **Anomaly effects on jitter are noticeable but still well within nominal mission values**

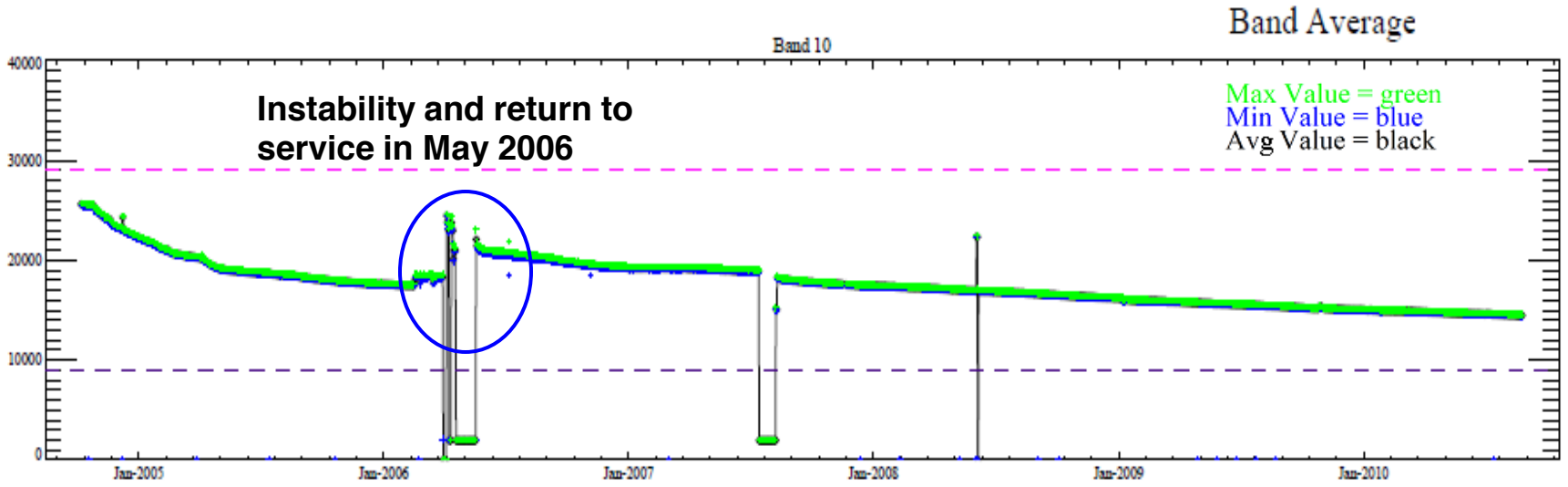
Trend Updates
Band 13 (HCl)

- Band 13 was powered off in 2006 to conserve life and to avoid adverse thermal effects on Band 10
- To answer long term HCl trend questions, Band 13 measurements were made in January of 2009 and 2010
- Measurements provided very useful science data and reaffirmed findings that Band 13 life is being conserved while Band 13 is off
- B13 life has been extended by duty cycling it but the 2010 measurement exhibited signs which might suggest that it is approaching its end of life



Trend Updates
Band 10 (ClO)

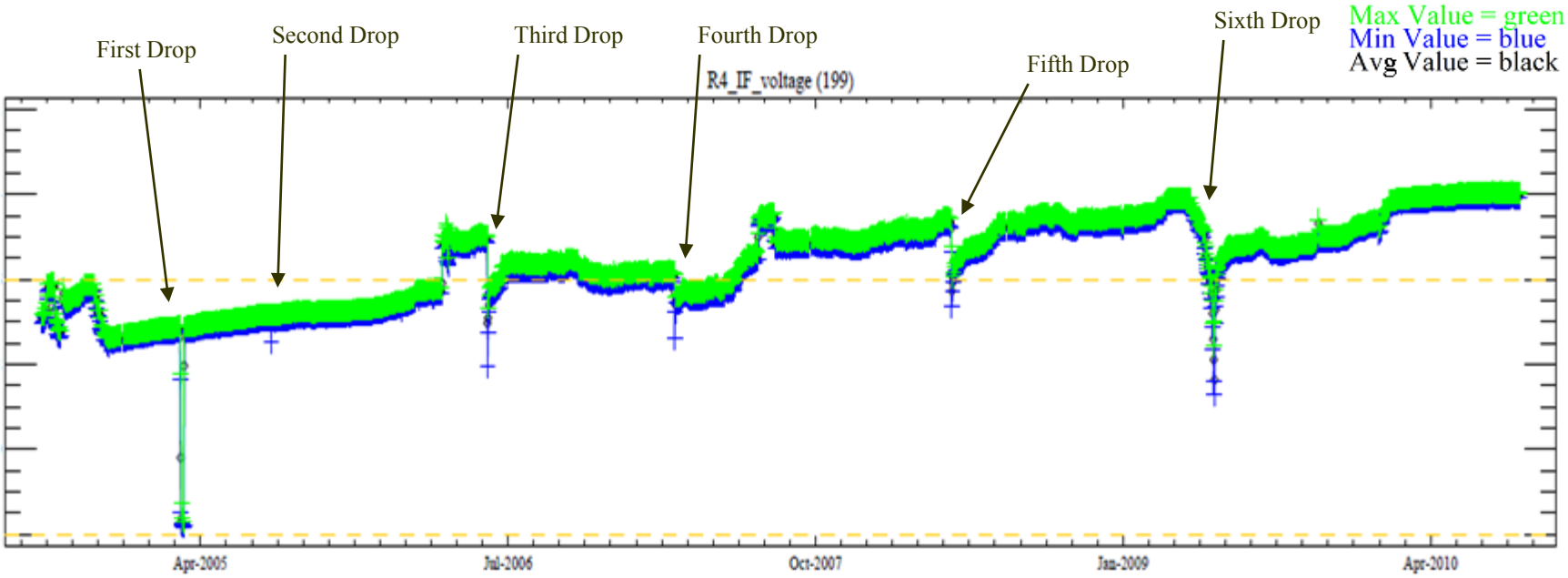
- **Band 10 has shown significant thermal sensitivities in the past leading to operations that minimize thermal cycling of the Band 10 specific hardware**
- **The Band 13 (HCl) measurements do cause a small thermal impact to Band 10 but caused no lasting adverse effects from Jan. 2009 and 2010 measurements**
- **Band 10 has remained stable since it was returned to service in May 2006**
- **Detail slide of March to May 2006 time frame in backup slides**



Trend Updates
R4 Receiver LO IF Power Monitor

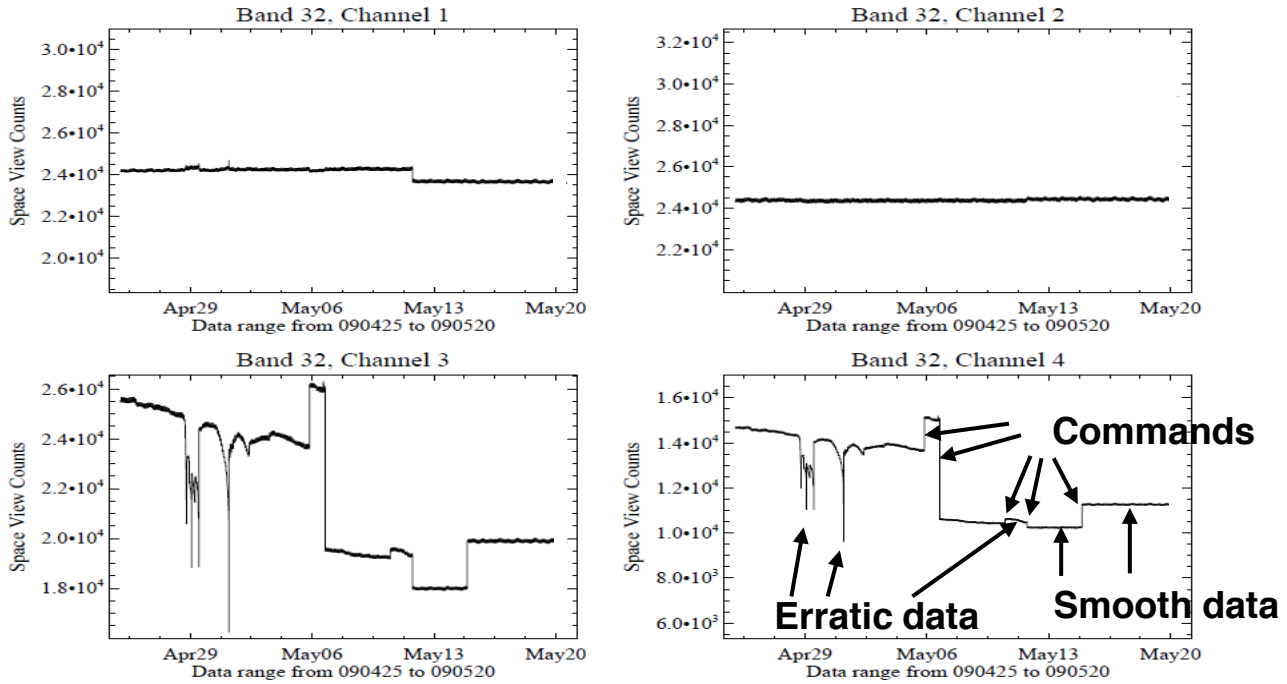
Telemetry of the 640 GHz receiver (R4) LO IF power has temporarily dropped on six occasions but has recovered each time

- **These drops have no observable effect in the science data, and are probably errors in telemetry**
- **No new drops since last reporting period**

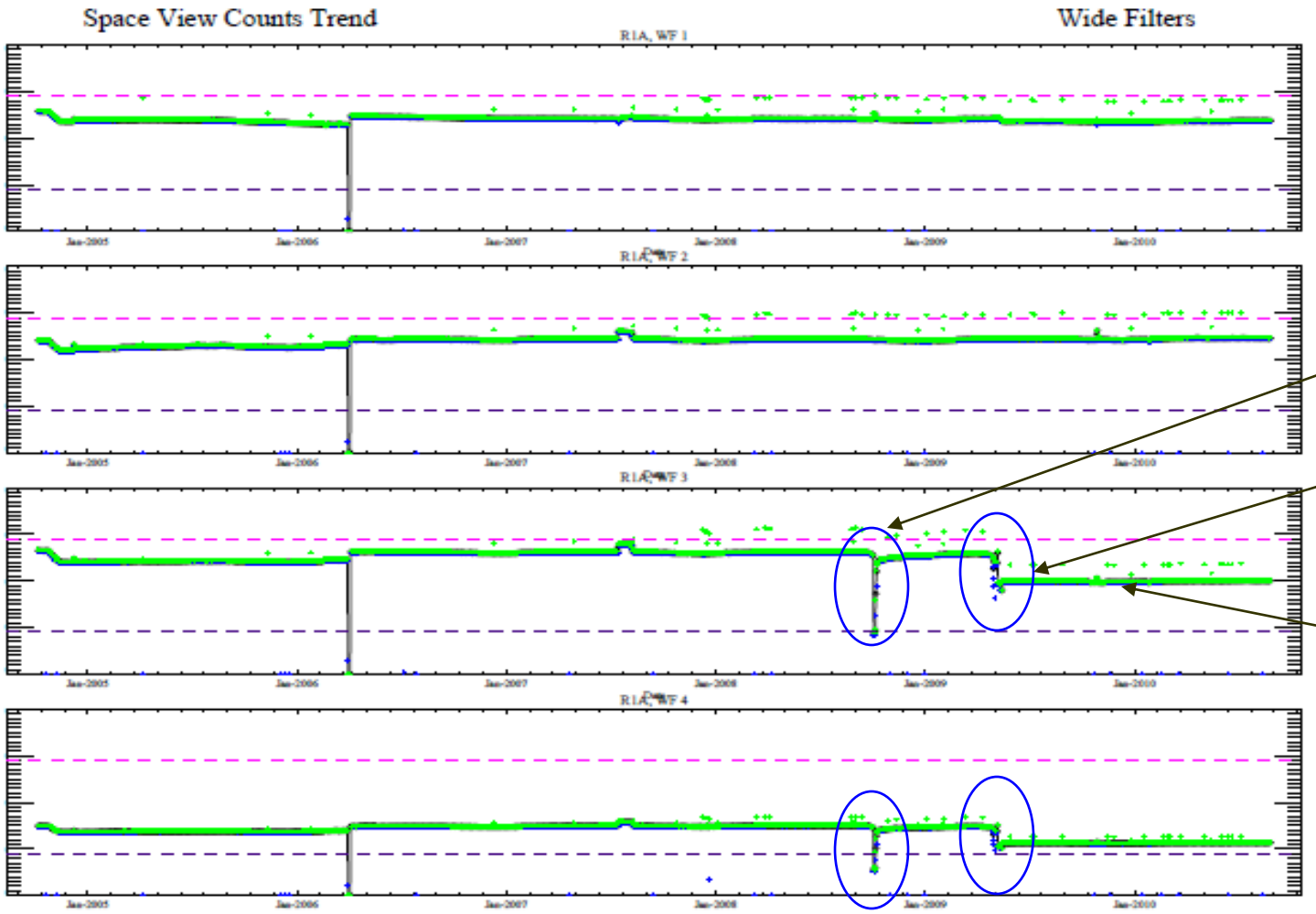


Trend Updates
R1A Wide Band (aka Band 32)
April – May 2009

- Band 32 Channels 3 and 4 have shown erratic behavior on 2 occasions
- During the second occasion (shown below), commands were sent to locate and isolate the erratic hardware
- Band 32 has remained stable since May 2009

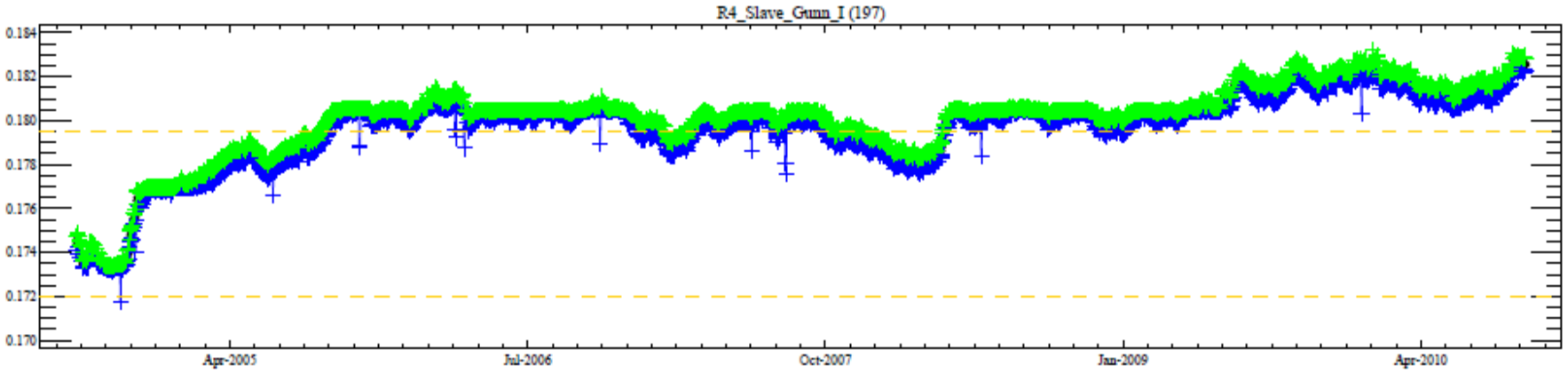


Trend Updates
Band 32 Channels1 to 4
Full mission trend



Trend Updates/Telemetry Watch List

R4 Slave Gunn Current



- **The R4 Slave Gunn Current is near a mission high level with an upward trend**
- **Recent trends show an ~ 2 mA change out of 180 mA**
- **Given the mission long trend for this point and its current value, we are not currently alarmed but we are monitoring it**
- **The yellow "guide lines" on these plots are arbitrary in value and are based on the launch and activation period**

Longevity Concerns

Spectrometer Module

- The magnitude of many science signals from the spectrometer module have been decreasing slowly since launch due to a known issue with a certain batch of voltage regulators
  - Existing test data on these components is insufficient to project remaining life.
  - While we are aware of this performance degradation, none of the more than 5 dozen of these parts have failed since launch

Longevity Concerns

Spectrometer Module

- **Band 6 and Band 27 share a common signal source**
  - **Band 6 signal levels have been decreasing slowly (due to voltage regulator issue) while Band 27 has held steady**
  - **We have sufficient attenuation adjustment available to boost Band 6 levels as needed, but, boosting Band 6 will also boost Band 27 and may cause it to enter saturation levels**
  - **Based on current trends, we have ~ 1 to 2 years before a few channels in Band 6 reach minimal levels and a Band 6/ Band 27 tradeoff decision may be necessary**

Operational Plans

- **Continue with MLS routine and calibration activities**
  - **AAA Reconditioning**
  - **Spectral Baseline updates**
  - **Moon Tracking Scans**
- **Bands 10 and 29 (ClO and HOCl)**
  - **Minimize thermal cycling of Bands 10 and 29 where reasonable**
- **Band 13 (HCl)**
  - **2010 measurement exhibited signs which might suggest that it is approaching its end of life**
  - **Given this behavior, our plans are to forgo a Band 13 measurement in 2011 and save it for later years**
- **THz Module (OH)**
  - **Likely measurement in August 2011**

Instrument Activity Requests

Moon Scan w/ Synchronized S/C Yaw

- **MLS Moon Scan with synchronized Aura yaw**
  - **This activity is currently being planned for Oct. 25, 2010 at ~ 22:30 GMT**
  - **Date and time selection based on lunar and seasonal phase matching to previous attempt of this activity**
  - **Will require a synchronized spacecraft yaw slew out using established DMU procedures**

- **Science Benefits:**
  - **Spreads MLS footprints over both horizontal and vertical directions on the Moon, which can make error bars in these scans up to 10x smaller**

Instrument Activity Requests

Moon Track with S/C Yaw

- **MLS Moon Tracking Scan #6; March, 2011**
  - **Similar to previous MLS Moon track activities**
  - **Would require small angle S/C yaw and hold**
  - **Current predictions target Mar. 21, 2011 – 11:24:44 with a yaw angle of ~ 0.64 degrees**

- **Science Benefits:**
  - **Additional data point for standing wave/radiometric cal. verification**
  - **Additional data point for radiometer co-alignment**
  - **If we duplicate the Mar. 2006 point on the Moon, we can evaluate long-term stability of antenna transmission**
  - **Long term stability knowledge is very useful for future missions**

Future Work

- **Separate MLS hot and cold TMONs for more specific response selection**
- **Update/remove specific MLS Survival limits from onboard limit set**
  - **I.e. MLS Primary, Secondary and Tertiary Reflectors**
- **Search for possible method of partial instrument shut down vs. MLS to Survival for any TMON trip**

Backup Slides

Contact Information

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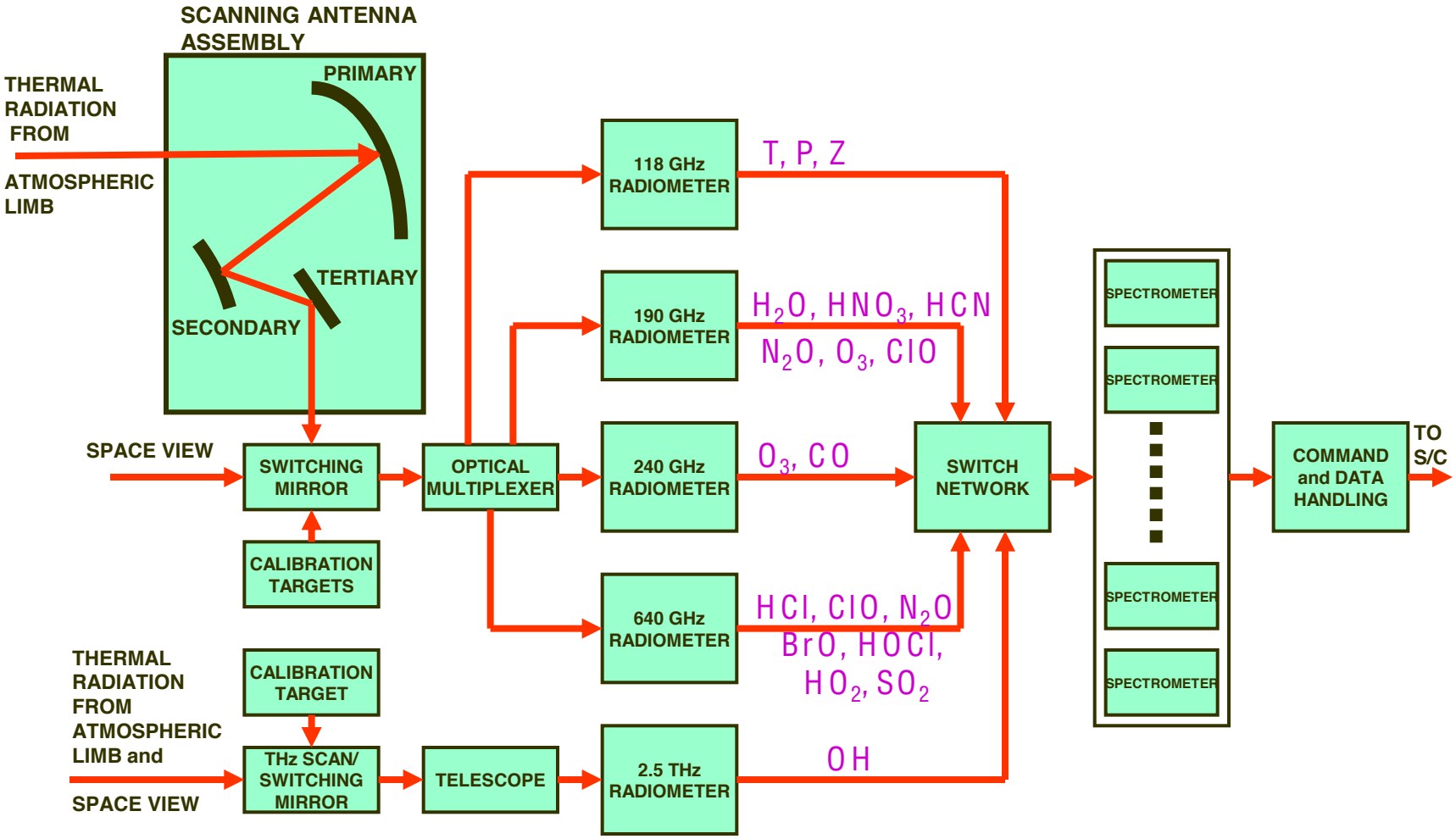
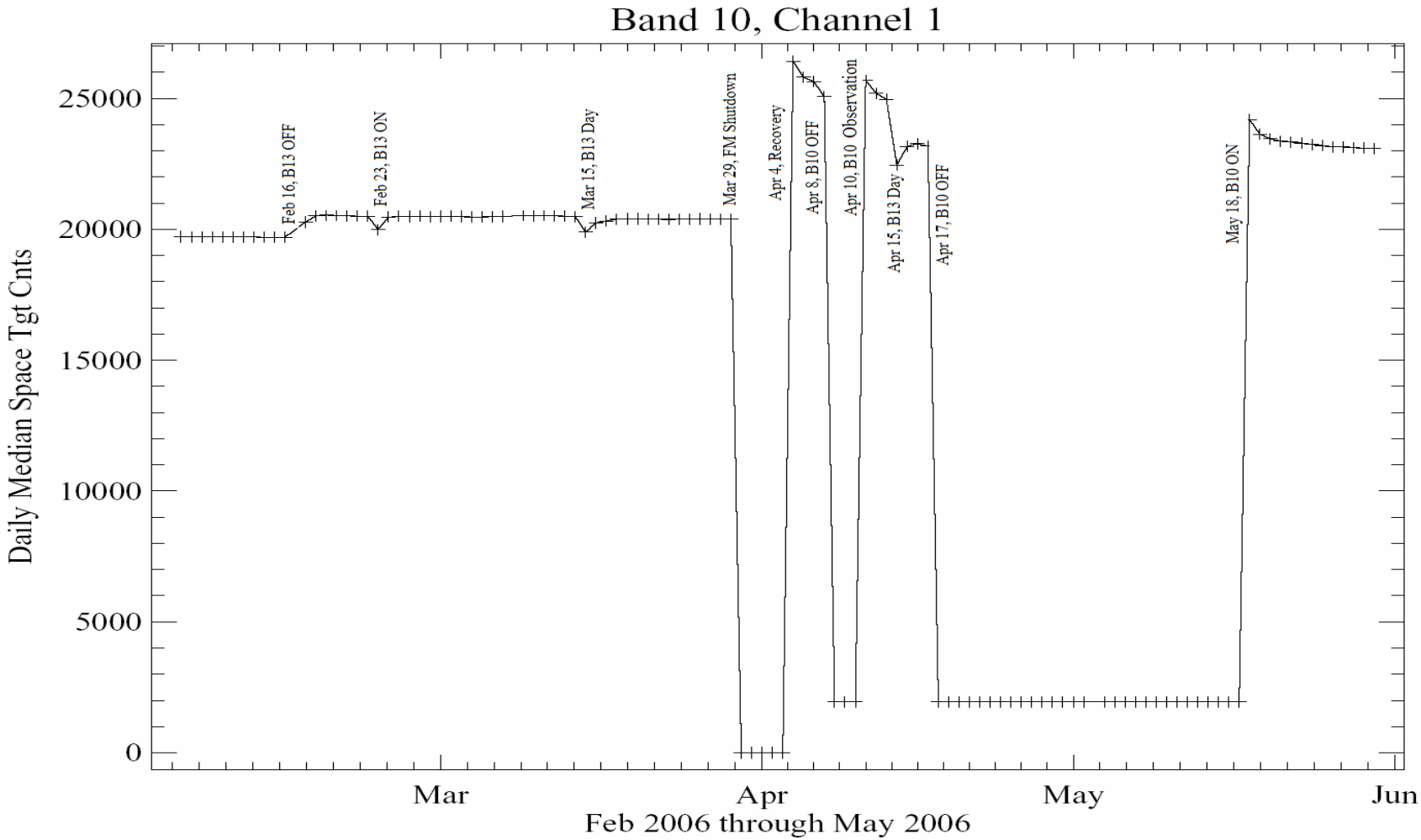
Instrument Overview
Signal Flow Block Diagram



MLS Band 10 (ClO) Trend

Focus: Feb. to May, 2006



THz Laser Output Power

- One data set per day (Max, Min, Ave)
- THz module now in standby mode
  - Laser off
  - Thz mechanism off
- Plans to reactivate THz science in August 2011 and June 2013